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Effect of Photoperiod at Low Light Intensities on Growth of Four Sedges

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The growth response of four species of Carex to light intensity and photoperiod was tested under greenhouse conditions at Laramie, Wyoming. Carex ebenea, C. tolmiei, C. phaeocephala, and C. egglestonii grew and developed normally under very low light intensities. Length of photoperiod affected only the time of flowering and the green weight of top growth.

Very little is known about the growth requirements of the high-altitude sedges (Carex spp). They grow in a wide variety of environmental conditions. Some species—C. brevipes W. Boott, for instance—will grow under dense shade in timber and also under maximum sunlight on open ridges, a rather wide range of adaptability. Preliminary investigations of factors affecting the growth of the sedges are underway. The purpose of this study was to determine the effect of length of photoperiod on the growth of four species of high-altitude sedges at low levels of light intensity.

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Methods

The study involved four samples of four species of sedges with two levels of light intensity and three photoperiods.

Six growth cells were installed on a greenhouse bench in Laramie, Wyoming. Each cell was enclosed with heavy white muslin to exclude light from adjoining cells. The cells were left open on top to provide better temperature control. The greenhouse was heavily shaded to reduce outside light from above as much as possible. Due to limited physical facilities, treatments were not replicated and conclusions are based on comparison of the sample means.

For the lower level of light intensity, the growth cells were equipped with two 40-watt, cool white fluorescent bulbs plus one 40-watt incandescent bulb. For the higher level of light intensity, the light source was doubled. Minimum light intensity, as measured with a

Weston illumination meter, Model 756,[2] was 300 foot-candles (ft.-c.) at pot level for the high-intensity treatment and 200 ft.-c. for the low-intensity treatment. During daylight hours, light intensity in all cells was as high as 800 ft.-c. on bright, sunny days. For most of the study period, however, daytime light intensities averaged 450 ft.-c. for the high-intensity treatment and 375 ft.-c. for the low intensity treatment. Light intensities in the alpine zone on the Snowy Range in Wyoming often range from 9,000 ft.-c. to 10,000 ft.-c.[3]

Three photoperiods, 10, 14, and 18 hours, were established. All periods included the normal hours of daylight by starting before daybreak and ending after dark. The 10-hour treatment was closely equivalent to the normal period of daylight.

Temperatures were maintained at 60° to 63° F. at night and about 68° to 70° F. during the day. Spot checks of temperatures within the six cells were remarkably uniform; they never varied more than 3° F. between cells, but were always 1° to 2° F. above the recording thermometer in the center of the greenhouse. Humidity varied from 40 percent at night to 80-85 percent during the day. This unorthodox temperature-humidity relationship could be the result of moisture condensation at night on the cold walls of the greenhouse. Plants were watered from below with tap water so that the soil surface was always slightly moist.

Species tested in this study were C. ebenea Rydb., C. phaeocephala Piper, C. tolmiei Boott, and C. egglestonii Mack. Plant materials were 1-year-old plants grown from seed in pots in the greenhouse. The plants were set outside in late August and allowed to go dormant. When completely dormant (no evidence of green top growth), the old growth was cut off at 1.5 inches above the root crown. Each plant was then cut into four equal-sized clones, and each clone was planted in a 6-inch plastic pot. Clones were assigned at random to the six treatments.

Criteria used to evaluate the treatments were (1) number of days for the first inch of new growth to occur, (2) number of days until the first flower stalk appeared, (3) number of flower stalks per plant, (4) maximum length of leaves, and (5) green weight of top growth. The study started October 18, 1965, and ended December 12, 1965. At completion, all plants that were going to flower in a reasonable period of time had flowered, and most of the seeds were ripe.

Results

The average growth response of the test species was different for all criteria of evaluation: This response was expected. Furthermore, all four species responded to light intensities and photoperiod in the same way.

The level of light intensity had a significant effect only on the green weight of top growth. At the high level of intensity, average top growth was 5.4 grams per plant as compared with 4.5 grams per plant at the low level (table 1).

Photoperiod affected the green weight of top growth and the time required for the first seedstalk to appear. For both criteria, the longer photoperiods produced the best growth response. The average weight of tops was 5.6 grams per plant for the 18-hour period, 5.2 for the 14-hour period, and 4.1 for the 10-hour period. The number of days until the first flower stalk appeared was 13.3, 15.0, and 15.8 for the same photoperiods, respectively. C. tolmiei produced no flower stalks.

Discussion and Summary

The failure of light intensity to influence more of the measured growth criteria may have been due to the relatively poor control of light intensity during the study. On the other hand, it has been shown that sedges will grow and develop normally under very low light intensities.[4] Smith and Johnson[5] found that

[2] *Trade names and company names are used for the benefit of the reader and do not imply endorsement or preferential treatment by the U. S. Department of Agriculture.*

[3] *Billings, W. D., Clebsch, E. E., and Mooney, H. A. Photosynthesis and respiration rates of Rocky Mountain alpine plants under field conditions. Amer. Midl. Natur. 75: 34-44. 1966.*

[4] *Johnson, W. M. A comparison of the effect of two light sources on the growth of Carex. (In preparation for publication.)*

[5] *Smith, Dixie R., and Johnson, W. M. Vegetation characteristics on a high altitude sheep range in Wyoming. Wyo. Agr. Exp. Sta. Bull. 430, 14 pp. 1965.*

Table 1. --Summary of effects of light intensity and photoperiod on four Carex species

Species and photoperiod	Days, first inch		Days, first flower		Flower stalks		Average leaf height		Green weight of tops	
	High	Low	High	Low	High	Low	High	Low	High	Low
	Number		Number		Number		Centimeters		Grams	
C. ebenea										
18 hours	6.5	7.0	11.2	13.2	1.5	2.5	53.0	41.5	6.0	3.9
14 hours	7.2	7.5	14.2	14.0	3.8	2.2	42.8	55.5	6.6	5.5
10 hours	7.8	7.5	15.5	12.5	2.2	1.2	44.5	47.0	4.2	3.8
C. phaeocephala										
18 hours	7.0	7.0	10.8	11.2	12.0	7.2	21.8	29.5	3.4	2.5
14 hours	7.0	7.2	12.0	12.8	8.5	7.2	25.5	21.8	2.3	2.1
10 hours	7.5	7.0	14.2	12.0	5.2	6.2	26.2	19.8	2.0	1.2
C. tolmiei										
18 hours	7.8	7.8	--	--	0	0	39.2	36.2	9.0	7.4
14 hours	7.8	8.0	--	--	0	0	38.8	39.8	7.4	6.9
10 hours	7.0	7.5	--	--	0	0	38.2	39.5	7.4	4.9
C. egglestonii										
18 hours	8.8	8.0	16.8	.6.8	2.2	3.2	66.0	58.0	7.3	5.5
14 hours	9.0	10.2	19.5	17.5	2.0	3.5	55.8	54.5	5.6	5.2
10 hours	10.0	8.5	17.8	22.5	2.0	3.2	44.0	51.8	3.4	5.0

much of the growth of subalpine species occurs under snow cover.

The complete lack of flowering on C. tolmiei is somewhat unusual. Rhizomatous species such as C. tolmiei have never flowered as vigorously in the greenhouse as rootstock species such as C. ebenea, but C. tolmiei has flowered, although sparingly, under somewhat higher light intensities than were used in this study. Individual plants of the species do flower vigorously in their native habitat. It is quite possible that high light intensities may be needed to trigger flowering activity in the plant. For the other species tested, low light intensities do not inhibit flowering.

Photoperiod was positively controlled during the study, but it also affected only top growth and days until flowering. Although better growth was obtained with the longest photoperiod, growth still occurred with the shortest photoperiod tested.

Growth appeared normal under all conditions of light intensity and photoperiod. Leaves were a normal healthy green color. Seedstalks produced normal fruiting bodies, and the seeds appeared to be fully formed and viable. No morphological deformities were observed in any plant.

It is entirely possible that the results observed here are realistic, and simply indicate that the sedges are capable of adequate growth under a wide range of environmental conditions.